during the present century fall within the group of minimum sun-spot years, the sixth (1854) being also a year of relatively few sun-spots (19·2 according to Wolf).

Dr. Hunter's avowed object, however, in writing his pamphlet was to prove that a cycle of drought sufficient to cause famine existed throughout the *whole* of Southern India, and with this end in view he has been content to show that a cycle of rainfall corresponding with the period of solar maculation existed merely for one single station, viz., Madras.

Having found a decided correspondence between the rainfall of Madras and the eleven-year period of sun-spots, he thence argues somewhat hastily that the same conditions apply throughout the whole of Southern India. This hasty generalisation from the results of one station situated in a vast continent, the rainfall of which varies completely both in amount and the season in which it falls, according to locality, has been strongly contested by Mr. Blanford, the Government meteorologist, who on making a careful comparison of the rainfalls of seven stations, three of which—Madras, Bangalore, and Mysore—are in Southern India, the others being Bombay, Nagpore, Jubbulpore, and Calcutta, finds that with the exception of Nagpore in Central India, which shows some slight approach to the same cyclical variation which is so distinctly marked in the Madras registers, the rest of the stations form complete exceptions to the rule adduced for Madras, in many of them the hypothetical order of relation being reversed. Mr. Blanford, however, shows that underlying the above irregularities a certain cyclical variation exists on the average at all the stations, the amount nevertheless being so insignificant (not more than 9 per cent. of the total falls) that it could not possibly be considered of sufficient magnitude to become a direct factor in the production of famine. It thus appears that the cycle of rainfall which is considered to be the most important element in causing periodic famines, has only been proved satisfactorily for the town of Madras. It may perhaps hold for the Carnatic and Northern Siccars—the country immediately surrounding Madras, though, owing perhaps to the want of rainfall registers in these districts, evidence with regard to this point is still wanting.

Though Dr. Hunter has thus been only partially successful, I would not attempt to detract in any way from the value of his able pamphlet, so far as it goes, an indirect effect of which has been to stimulate meteorological inquiry and research in the same direction throughout India. The meteorology of this country, from its peculiar and tropical position, is in such complete unison with any changes that may arise from oscillations in the amount of solar radiation and their effects upon the velocity and direction of the vapour-bearing winds, that a careful study of it cannot fail to discover meteorological periodicities in close connection with corresponding periods of solar disturbance. In connection with the previous remarks, and as showing what a close connection exists between solar and terrestrial meteorology, I may observe that Mr. Hill, the meteorologist for the North-West Provinces, and myself, have coincidently discovered the existence of a remarkable cycle in the *winter* rainfall of Northern India, between the latitudes of 20° and 30°, corresponding *inversely* with the period of solar spots, *i.e*, the maximum winter rainfall coincides with the minimum period of sun-spots, and *vice versâ*.

As a failure of the winter rains in the Northern Provinces in 1860-61 (*years of maximum sun-spot*) has been the cause of a severe famine, this theory, if completely established, would not be without its value in the economical administration of the North-West Provinces and the Punjab. I have not at present examined the rainfalls of all the stations in the Upper Provinces, but Mr. Hill, having readier access to them than myself, has probably done so to a larger extent, and tells me that the results of his investigations are similar to my own in bearing out the preceding hypothesis. A theory is not wanting to account for this tendency to vary inversely with the sun-spots, if we, according to opinion held by Drs. Hahn and Köppen, Prof. Piazzi Smyth, and Mr. Pogson, the Government astronomer at Madras, assume that the sun's heat is greater in years of minimum sun-spot. For in these years the anti-trade current, the descent of which upon the Himalaya and Northern India in the winter is generally understood to be the vehicle of the rain at that season, would be owing to the increased evaporation over the Southern Indian Ocean, reinforced with a larger supply of vapour than usual, while in years of maximum sun-spot the supply would be smaller. At all events, whatever be the real cause, the facts as far as we have gone, are exceedingly favourable to the existence of such a cycle. Calcutta, though lying close to the tropics, and therefore coming in for a small share of winter rainfall, still shows the preceding relation to a wonderful extent, and as its register of rainfall extends farther back than most of the other North Indian rainfalls, furnishes a more trustworthy result than many other stations whose rainfalls registered only for short periods scarcely afford more than a slight balance of probability in favour of the assumption. The following table is arranged in a double series of years occupying the same position in the spot-cycle, and gives the average rainfall for each double series for the months of November, December, January, February, March, and April, from 1837 to 1876 inclusive. I have indicated the groups containing the years of maximum and minimum sun-spot. The maximum rainfall will be seen to occur in the latter, and the minimum in the former group.

Calcutta Rainfall during the months of November, December, January, February, March, and April.

	Years.						Average rainfall of group in inches.
11th	1876	1865	1854	1843		Group containing years of minimum sun-spot.	8·49
1st	1877	1866	1855	1844			6·44
2nd		1867	1856	1845			
3rd		1868	1857	1846		... ...	5·93
4th		1869	1858	1847			
5th		1870	1859	1848	1837	Group containing years of maximum sun-spot.	4·44
6th		1871	1860	1849	1838		
7th		1872	1861	1850	1839	... ...	5·03
8th		1873	1862	1851	1840		
9th		1874	1863	1852	1841	... ...	6·15
10th		1875	1864	1853	1842		
Eleventh series repeated ...						... ...	8·49

Further analysis only tends to render the connection still more evident, but I have no time to add anything further. In conclusion I need only remark that Jerusalem, which is situated somewhere about the same latitude as Lahore, and receives its total annual supply during the winter months alone, fully bears out the hypothesis as far as records show from 1846 to 1859.

Bankipore, Patna E. D. ARCHIBALD

Reproduction by Conjugation

IN Prof. Allen Thomson's Inaugural Address to the British Association, I find the following sentence, referring to the simplest form of sexual reproduction among cryptogams, known as conjugation:—"In more ordinary cases, as in *Spirogyra*, where the embryo is formed in one of the two cells, it seems to be indifferent in which of them it is formed." If my own experience may be taken as trustworthy and adequate, there is one fact in connection with this phenomenon which would seem to show that it may not be altogether indifferent, and that the differentiation of male and female elements may be carried back even one step further than is stated by this distinguished biologist. When two filaments—which we may call A and B—are conjugating, then, as far as my observation has gone, the direction of conjugation is uniformly the same, *i.e.*, either the contents of every cell in A pass over into the adjacent cell of B, or the reverse; we never find the contents of some of the cells of A passing over into B, and the contents of some of the cells of B passing over into A. If this is so, and if we call the filament in which the zygospores are ultimately produced A, then it is clear that we may fairly call A the female and B the male filament; and it would appear certain that there must be some hitherto undetected difference between them. My own observations in this respect relate almost exclusively to *Spirogyra*, and I shall be very glad to know if they are confirmed, or otherwise, by those of more experienced algologists.

ALFRED W. BENNETT

The Greenland Foehn

HOFFMEYER'S facts respecting spells of warm weather in the Arctic winter, as reported in NATURE, vol. xvi. p. 294, are very interesting, but his explanation of them seems demonstrably insufficient. He thinks they are a phenomenon of the same kind with the *Foehn* of the Alps, which latter he explains by saying that a wind which at its origin is saturated with moisture will, when it is forced over a mountain chain, be raised 1° Cent. for

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every 200 metres of height of the mountains. The heat thus gained is liberated in the condensation of the vapour. I believe this is satisfactory as regards the *Foehn*.

But this will not account for a rise of the temperature of Southern Greenland from its mean December temperature, which, according to Dové's map, is below freezing, to 14° C. A rise of 14° C. would require, according to the above law, a mountain chain 2,800 metres, or about 8,000 feet in height, and there is none in Greenland approaching this.

I used to think that great rises of temperature in the Arctic winter were due to the wind tearing up the frozen surface of the sea, and liberating the heat of the water below; but this will not account for an increase of temperature above freezing. I have no explanation to offer. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, August 13

Does Sunshine Extinguish Fire?

IT is a popular belief that a fire will not burn if exposed to the sun, and, from all I have observed, it seems well founded. Can any of your readers favour me with an explanation of the phenomenon, if true; or is it a mere superstition?

Schwarzwald, August 11 CHARLES WATSON

OUR ASTRONOMICAL COLUMN

THE OPPOSITION OF MARS, 1877.—The present opposition of the planet Mars offers conditions so nearly analogous to those of the opposition in 1862, that the many fine drawings made in that year, a number of which are contained in vol. xxxii. of the "Memoirs" of the Royal Astronomical Society, become available for comparison with such as may be made during the actual opposition. The same hemisphere of the planet is presented to the earth, and our depression from the martial equator is sensibly the same; thus, at opposition in 1862 the angle of position of the visible (southern) pole was 145°·3 and the earth's depression −22°·7, while at the opposition of 1877 the figures are respectively 160°·3 and −22°·5. The least distance of Mars from the earth in 1862 was 0·406, while in 1877 it is 0·377.

Notwithstanding Secchi observing in 1858 found the features upon the disc of Mars irreconcilable with those delineated in Mädler's drawings made under similar circumstances in 1830, it was sufficiently evident at the opposition of 1862 that these differences are to be attributed to the temporary conditions occasioned by clouds of varying density, form, and extent, in the atmosphere of the planet itself, heightened perhaps in some degree by the state of our own atmosphere at the times of the observations. A striking instance in support of this conclusion was afforded by Mr. Lockyer's observations on September 25, 1862. At 10h. 44m., when his drawing No. 14 was completed, the well-known spot *a* of Mädler was *quite invisible*, while when No. 15 was made shortly afterwards, this spot was "among the most prominent features upon the planet's disc."

There would appear now to be little doubt that the green and red portions of the disc do really represent seas and continents, and are not due to the effect of contrast, another explanation which has been suggested. During the actual favourable appearance of the planet, we may expect that measures will be made which will admit of a closer determination of the position of the axis of rotation than any yet obtained. The results at present upon record are (1) Sir W. Herschel's, which assigns for the longitude of the ascending node of the equator of Mars upon his orbit, 79° 27′ for 1872, and for the obliquity of his ecliptic 28° 42′. The reduction by Oudemann's of Herschel's measures, make these figures 79° 18′ and 20° 53′ respectively; (2) Schroeter's, as given by M. Terby, which places the south pole in 172° 54′·7, with latitude 60° 33′·2, whence we find for 1798, longitude of ascending node of equator on orbit, 84° 54′, obliquity of ecliptic 27° 57′ for 1798; and (3) Oudemann's reduction of Bessel's measures with the Königsberg heliometer, made September 28, 1830, January 21, 1835, and February 11, 1837, giving for the place of the ascending node 80° 50′, and for the obliquity 27° 17′ for 1834. With the last values which have been generally adopted, we have for the ascending node of the equator of Mars upon the earth's equator (N), and its inclination thereto (I):—

$$N = 47^\circ\ 42' + 0'{\cdot}50\,(t - 1850)$$
$$I = 39\ \ 52 - 0{\cdot}25\,(t - 1850).$$

The following table showing the angle of position of the visible pole of Mars, and the elevation of the earth above the plane of his equator, at the oppositions between 1850 and 1880, has been calculated from the above elements, and may be of interest to some readers; the least distance of Mars from the earth is added:—

Date of opposition.	Position of visible pole.	Elevation of earth.	Least distance of Mars.
	° ′	° ′	
1852, Jan. 24	23 16	9 8 N.	0·660
1854, Feb. 26	343 46	22 6 N.	0·675
1856, April 2	35 2	23 30 N.	0·625
1858, May 15	40 45	12 4 N.	0·514
1860, July 17	192 34	10 47 S.	0·391
1862, Oct. 5	145 17	22 42 S.	0·406
1864, Nov. 30	142 37	6 29 S.	0·534
1867, Jan. 10	343 54	10 24 N.	0·636
1869, Feb. 13	7 37	21 40 N.	0·677
1871, March 19	28 35	24 53 N.	0·636
1873, Feb. 13	41 2	17 59 N.	0·563
1875, June 19	209 7	0 51 S.	0·433
1877, Sept. 5	160 14	22 31 S.	0·377
1879, Nov. 12	138 48	13 54 S.	0·482

A glance at this table exhibits a well-known condition that when Mars is nearest to the earth and when we have consequently the best opportunities of studying the features upon his disc, his southern hemisphere is always directed to the earth, and hence we are likely to be better acquainted with that hemisphere than with the northern one, which is turned towards the earth only at the greater distances of Mars.

THE SATELLITES OF SATURN.—A series of observations of all the eight satellites of Saturn by Prof. Asaph Hall, dated from Washington in December, 1876, has at last made its appearance in No. 2,145 of the *Astronomische Nachrichten*.

SATELLITES OF MARS.—A telegram from the Smithsonian Institution to M. Leverrier, received August 19, notifies the extraordinary discovery of two satellites of Mars by Prof. Asaph Hall, of the U.S. Naval Observatory at Washington. The telegram runs thus: "Two satellites of Mars by Hall at Washington, first elongation west, August 18, eleven hours, Washington distance, eighty seconds, period thirty hours, distance of second, fifty seconds."

THE BRITISH ASSOCIATION

PLYMOUTH, *Tuesday*

THE Plymouth Meeting of the British Association has not realised, as far as numbers are concerned, the success which we anticipated last week, and which was indicated by the business done on the days immediately preceding the opening of the meeting.

The attendance of the regular members from a distance has been very good indeed, and can compare favourably with meetings that have gone before it, but the visit of the British Association, while opening wide the gates of hospitality of the people of Plymouth, does not seem to have awakened the scientific interest of the community sufficiently to cause many to enlist in its ranks. It is seldom that so small a number of local members have been added to the list

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